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RESEARCH

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X*TRAX™
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Transportable Thermal Separator for Solids Contaminated with Organics

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X*TRAX™ - TRANSPORTABLE THERMAL SEPARATOR for ORGANIC CONTAMINATED SOLIDS

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ABSTRACT

Chemical Waste Management (CWM) has developed a patented system, X*TRAX™, that thermally separates organics from solids, such as soils, pond sludges and filter cakes, in an indirectly heated rotary dryer. Vaporized organics and water are transported with a nitrogen carrier gas to a gas treatment system where they are condensed and collected as a liquid. The gas is then reheated and recycled to the dryer. To control oxygen, a small portion of the carrier gas is vented to atmosphere through carbon adsorbers. CWM has constructed a full scale transportable X*TRAX system that has been contracted for a PCB soils cleanup at a mid-size Superfund site in the Eastern U.S. The system is expected to mobilize in mid to late 1990 on that site. In an innovative combination, the condensed organic liquid will be chemically dechlorinated on site prior to off site disposal. A SITE demonstration test will be conducted at this site during the performance of tha cleanup. Since early 1988, CWM has operated both a 5 ton/day pilot demonstration system, and a 2-4 lb/hour laboratory system for treatability studies. The pilot system has recently completed ten tests using TSCA regulated PCB soils and is currently in preparation for an extensive testing program using RCRA regulated materials. In addition to a number of surrogate wastes, the laboratory system has processed over 19 RCRA and TSCA regulated waste materials.

X*TRAX™ - TRANSPORTABLE THERMAL SEPARATOR for ORGANIC CONTAMINATED SOLIDS

1. INTRODUCTION

The widespread problem of soils and solids that are contaminated with organic chemicals, coupled with the EPA's increased restrictions on organics in landfills has resulted in the unavoidable fact that millions of cubic yards of soil and solids will have to be treated to reduce or eliminate the organics. Historically, the most likely treatment alternative has been high temperature incineration, which is costly, difficult to permit, and requires lengthy mobilization periods for system installation and trial burns. Chemical Waste Management (CWM) believes that many of these waste streams can be treated using a thermal separation system; in essence, by drying them. Wastes such as contaminated soils, pond or process sludges, filter cakes and others are likely candidates. Laboratory and pilot testing by CWM has shown that at low temperatures (500-800°F) many organic compounds including high boiling compounds (PCBs) can be successfully separated from solids such as soil, sand, etc. Thermal separation is now a treatment option with significant advantages in all of the above mentioned areas for a broad class of waste materials that have relatively low organic concentrations - typically less than 10%.

Contaminated solids are heated in an indirectly fired rotary dryer to volatilize the organics. The vapors are carried to a gas handling system with an inert gas where they are scrubbed for particulate solids and cooled to condense the organics. The carrier gas is reheated and recycled to the dryer. The recovered organics can be reclaimed, used on- or off-site as supplemental fuel or destroyed by incineration. Organic contaminants can range from high boiling, semi-volatile compounds such as PCBs, to low boiling, volatile compounds such as RCRA regulated solvents.[1,2] This X*TRAX process has been granted U.S. Patent No. 4,864,942.

CWM has been actively developing the X*TRAX process since late 1986. This paper describes the X*TRAX process and each of the three X*TRAX systems that have been constructed: laboratory, pilot and full scale. Test data are presented for both the lab and pilot systems. The first full scale unit has been functionally tested and will be moved to a Superfund site in mid to late 1990, depending on receipt of approvals from EPA.

2. SYSTEM DESCRIPTION

The X*TRAX system is a separation process to remove volatile or semi-volatile compounds from a solid matrix. Thermal energy is the driving force used to affect the separation. The process flow diagram is presented in Figure 1.

Feed material, which can be either solid or pumpable sludge, is fed into the dryer. The dryer is an externally fired rotary kiln. It is essentially a sealed rotating cylinder with the feed material tumbling inside and the heat source (propane burners) on the outside. Since the dryer is externally fired, the combustion products do not contact the waste material (feed) being processed. The use of an externally fired dryer has two distinct advantages. First, and most important, is that the combustion gases do not pass through the associated air pollution control (APC) devices. Propane is a readily available clean burning fuel. Air permits for vent stacks from propane combustors are easily obtained, usually without any required APC devices. This allows the APC devices for X*TRAX to be one tenth to one hundredth the size of that for an equivalent capacity incinerator. In addition, the small volume of nitrogen carrier gas discharged makes cleaning it to very high standards quite inexpensive. The second advantage of external firing is that it makes the X*TRAX system a separation process, not an incinerator because no organic combustion occurs. It is usually much easier to permit a separation

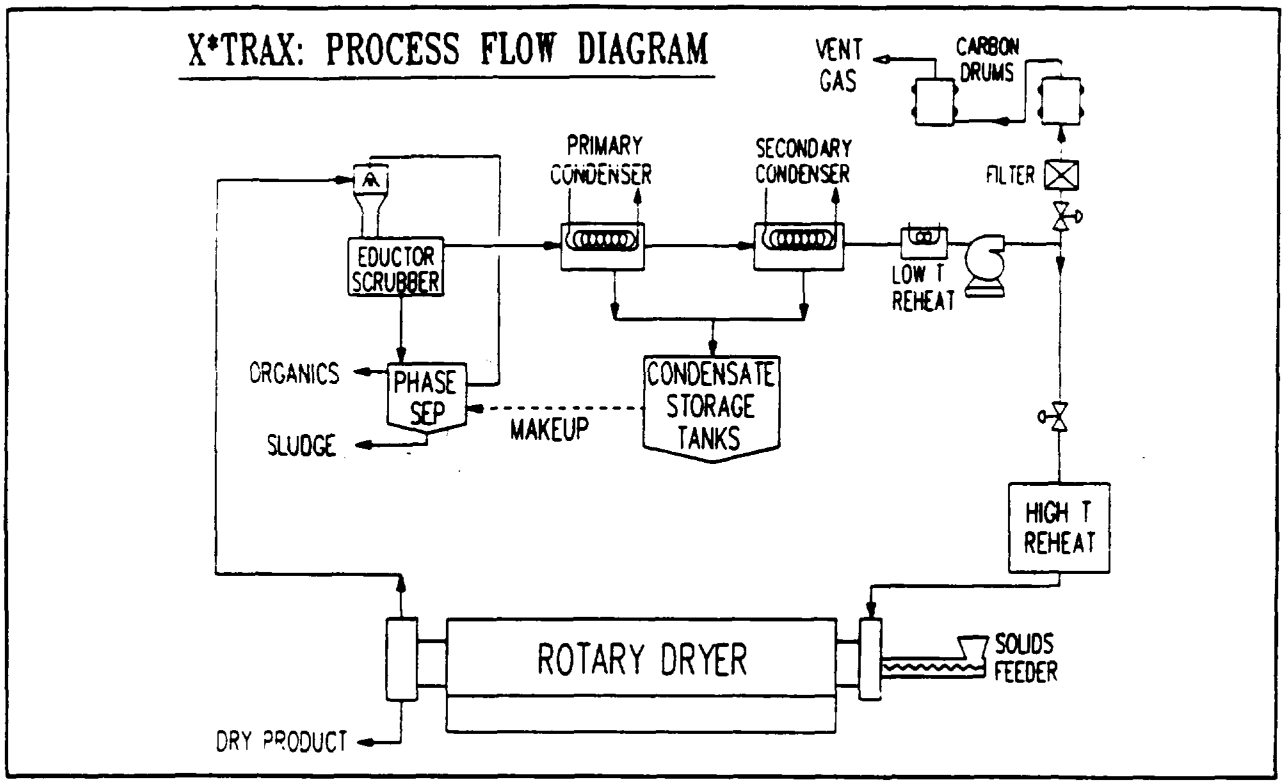

Figure 1

process than a waste incinerator.

The heated solids are discharged from the dryer as a powdered or granular dry material. For most applications, water will be mixed with the exiting solids to cool them and to prevent dusting. By adding reagents at this point, metal containing wastes can be stabilized with the reagent cost being the only additional expense. The water will normally be condensate from the gas treatment portion of X*TRAX.

The carrier gas first passes through a liquid scrubber where entrained solid particles are removed and the gas stream is cooled to its saturation temperature. The scrubber also removes a portion of the volatilized organics. The recirculated scrubber water continuously passes through a phase separator. The phase separator collects any condensed light organic from the liquid surface and continuously discharges a bottom sludge containing solids, water and organics. The sludge is dewatered using a filter press. The dewatered solids are either returned to the feed stream or disposed of.

The scrubbed gas passes to the first heat exchanger where it is cooled to 10°F above ambient temperature. This heat exchanger will produce the bulk of the liquid condensate. The carrier gas now goes to a second heat exchanger where it is cooled to 40°F. The liquid condensates from both heat exchangers are mixed and allowed to gravity separate. Organics are removed for disposal. The condensed water is used to cool and dedust the treated solids exiting the dryer.

The 40°F carrier gas now contains some residual moisture and organics that were present in the feed at levels equal to or less than their equilibrium saturation concentration at 40°F. The carrier gas then passes to a recirculation blower. After the blower, 5 to 10% of the carrier gas is vented, and the remainder is heated to 400-700°F before returning it to the dryer.

The process vent gas stream passes through a particulate filter (2 micron) and then through a carbon adsorber, where at least 80% of the remaining organics will be removed. Actual practice has shown removal efficiencies by the carbon ranging from 89 to 98%. This gas is then vented to the atmosphere. A 100 ton per day X*TRAX system would release anywhere from 0.25 to 5 pounds per day of VOCs which is considerably lower than most regulatory constraints.

2.1 Laboratory

Since January, 1988, CWM has operated a laboratory X*TRAX system at its Riverdale Technical Center in Riverdale, Illinois. This system typically processes 2 to 4 lb/hour. It consists of a 4-inch diameter, 48-inch long electrically heated tube furnace coupled to a small scale gas treatment system that closely simulates the pilot and full scale systems.

This unit is used for treatability studies and to screen materials for pilot testing and commercial operations. To date, 23 separate test runs have been performed, with 19 being on actual RCRA and TSCA waste materials. The laboratory system was operated under CWM's TSCA R&D permit for the Riverdale Center, as well as CWM's Illinois authorization for RCRA treatability studies.

In September of 1989 the system was transferred to Chem-Nuclear Systems Inc. (CNSI) in Barnwell, SC. CNSI is using the system to evaluate the applicability of X*TRAX to treating mixed (radioactive/hazardous) wastes, having conducted two tests to date. A second laboratory X*TRAX system has been constructed and is operational at the new CWM R&D facility located in Geneva, IL. A new TSCA R&D permit was granted on January 30, 1990.

2.2 Pilot System

The pilot X*TRAX system is a mobile unit mounted on two semi trailers; one containing the dryer and another containing the gas treatment system. The dryer is 24-inch diameter, 20 feet heated length, with 10 propane burners. The pilot system has a nominal capacity of 5 tons per day for a feed material containing 30% moisture. Figure 2 is an artist's rendering of the pilot X*TRAX system.

The pilot system was used to provide design data on capacity, material handling, and gas system performance for the full scale system. It has been and continues to be used to provide treatability and emissions data on candidate waste streams, and is available for the performance of demonstrations.

The pilot system became operational in January, 1988. Since then it has been used to test over 87 tons of materials, including: 59 tons of simulated RCRA wastes, 5 tons of mixed radioactive/hazardous waste and 20 tons of TSCA regulated PCB soils.

The pilot system is presently installed at CWM's Kettleman Hills Facility in central California. The system is operated under a variety of permits at Kettleman. The most basic of these is an operating permit from Kings County, allowing CWM to have an air emission source. CWM also has a variance from the California Department of Health Services to treat non-RCRA wastes such as California special wastes. The testing on PCB materials was conducted under a three month R&D permit from the EPA's TSCA branch, which expired October 4, 1989. A 90 day extension was granted starting November 1, 1989. CWM has also filed for a RCRA RD&D permit to allow for testing on RCRA regulated materials. This permit request is currently under review, and is expected to be granted during the third quarter of 1990. CWM will perform one year of testing under the RD&D permit, investigating all types of RCRA wastes but focusing on those that have or will be restricted from land disposal ("land banned").

2.3 X*TRAX Model 200 Full Scale Production System

The X*TRAX Model 200 is a full scale production system that was constructed for onsite cleanup of contaminated soil. The system is capable of treating 125 tons per day of contaminated soil with a moisture content of 20%. Like the pilot system, the Model 200 has a rotary dryer and a gas treatment

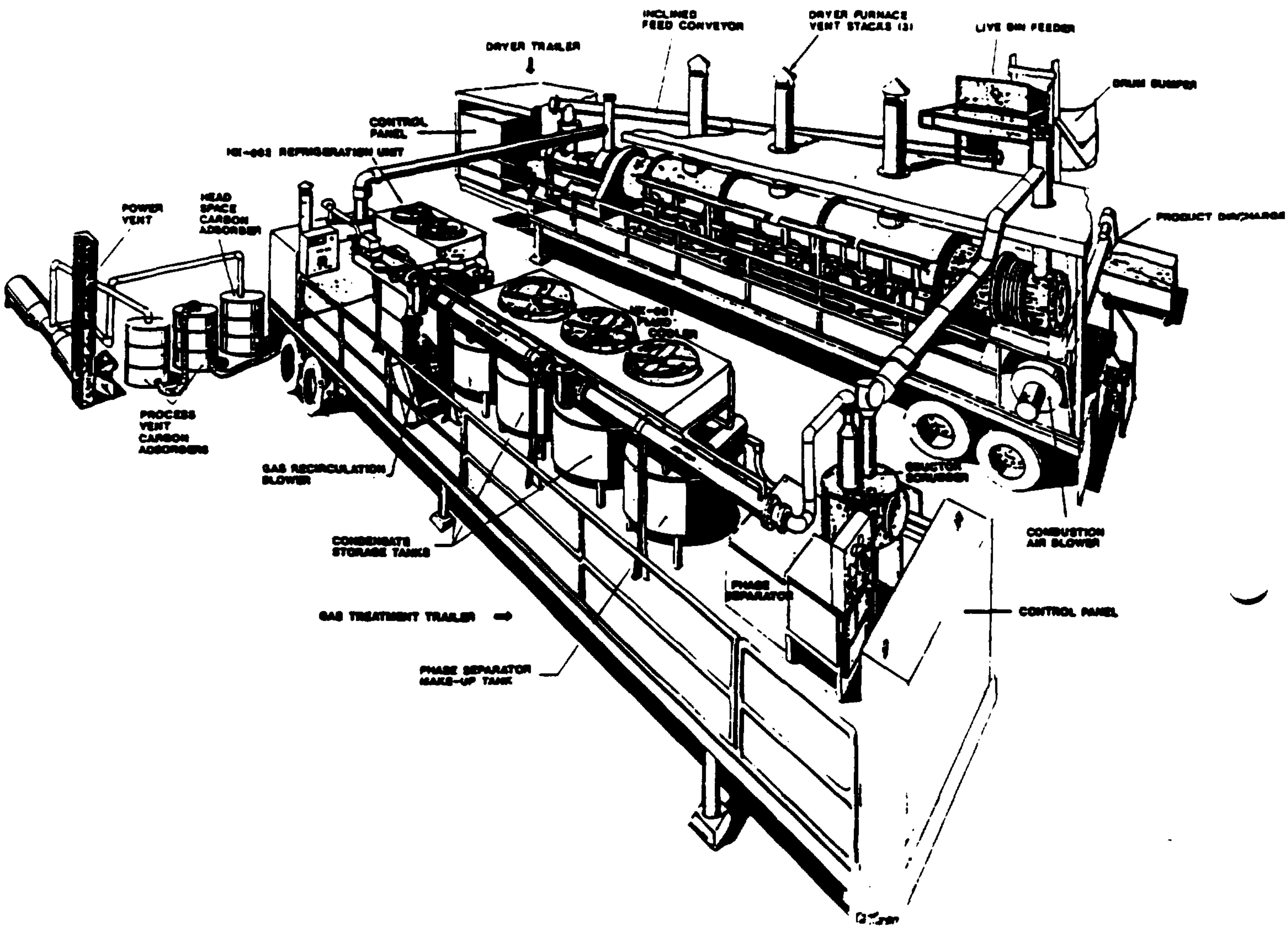

Figure 2 - Pilot X*TRAX

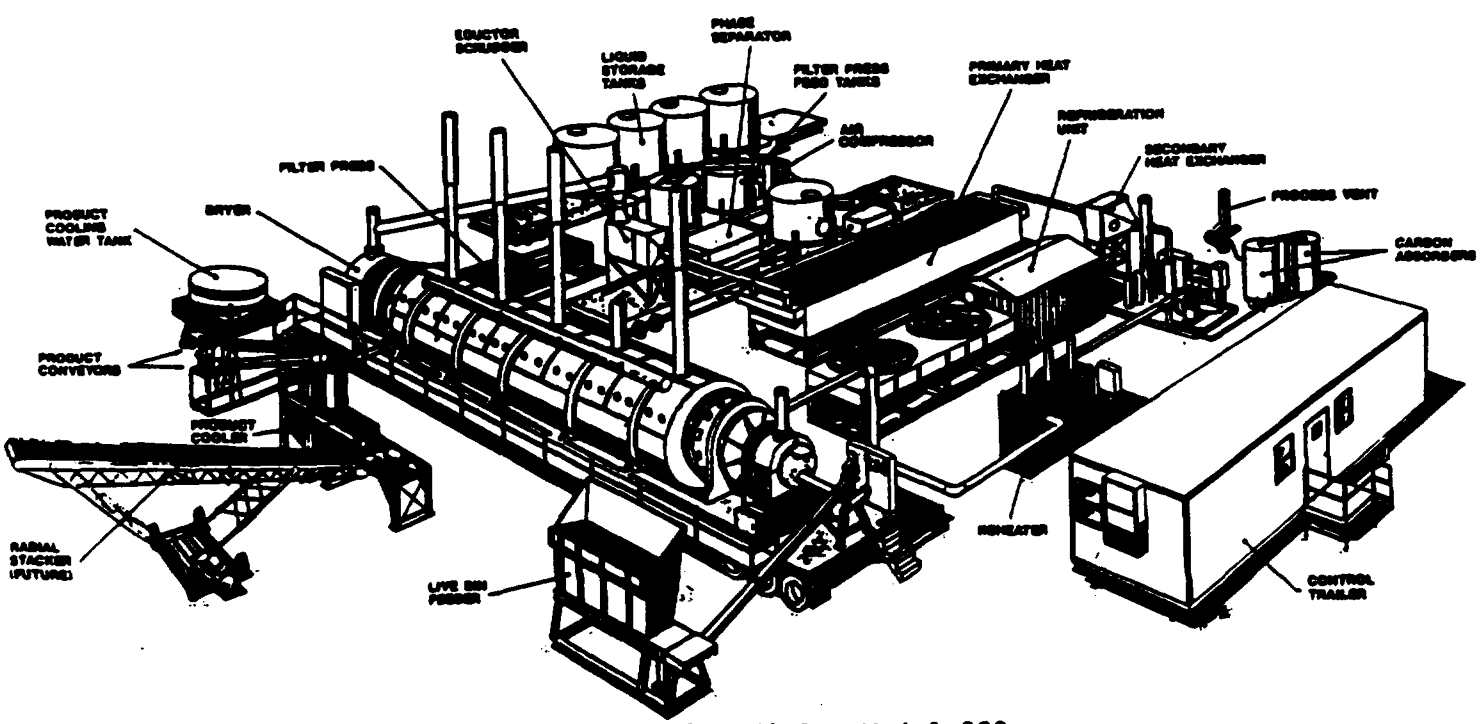

Figure 3 - X*TRAX Model 200
Full Scale System

system; however, they are much larger, requiring the use of modular construction techniques. The Model 200 is fully transportable, consisting of three semi trailers, one control room trailer, eight equipment skids and various pieces of removable equipment. Figure 3 is an artist's rendering of the Model 200 system. The area required for the equipment measures 120 ft. by 120 ft.

All of the equipment has been designed for over the road transport anywhere in the U.S. or Canada. The dryer is the largest of its kind that can be transported over the road. The components are mobilized to the project site and assembled using a relatively small 15 ton crane. Approximately three to four weeks are required to completely install the equipment. Site preparation involves grading the site level and providing a firm base such as compacted gravel. Concrete footings are not usually required; however concrete housekeeping pads may be required. All skids or trailers that normally contain liquids have integral liquid containment curbs for spill control.

The system requires three phase, 460 volt electric power, propane storage tanks, and a liquid nitrogen storage tank. The electric motors are sized such that the system can be operated from a commercially available diesel generator if electric power is not available at the site.

Construction of the Model 200 system has been completed and the unit has been functionally tested. CWM has a series of performance tests planned during which the unit will be operated on non-regulated feed materials.

3. SITE DEMONSTRATION PLANS

In 1988 EPA contracted with CWM to perform a demonstration of X*TRAX under the Superfund Innovative Technology Evaluation (SITE) program. Under this contract, EPA will perform sampling and prepare the various reports and CWM will provide the equipment, waste streams, and permits, as well as operate the equipment. CWM was to use the five ton/day pilot X*TRAX system on two or three different PCB contaminated soils during the TSCA phase of the pilot testing that CWM conducted at its Kettleman Hills Facility. Because of the difficulty of coordinating the schedule for development of a SITE demonstration test plan with the short duration permits that CWM received for the TSCA testing, EPA elected not to perform the demonstration as planned.

However, as a result of pilot work done by CWM during the TSCA testing at Kettleman, the company was awarded a contract to clean up a PCB contaminated site using the X*TRAX Model 200, full scale system. CWM and EPA have agreed to perform a SITE demonstration during the active part of the remediation. This is currently scheduled for late 1990 or early 1991. A demonstration using the Model 200 will fully evaluate the operational capabilities of the X*TRAX technology, as well as provide treatability data.

The site of the remediation is primarily contaminated with PCB's, with some contamination from chlorinated solvents such as trichloroethene and perchloroethene as well. The site has a sandy soil underlain by clay. A marshy wetland area of the site with high humic content will also require treatment. The X*TRAX Model 200 will be used to clean the soil, which will then be returned to the site as backfill. A cleanup standard of 25 ppm was established in the Record of Decision (ROD) for soil returned to the non-wetland portion of the site.

An interesting requirement of the ROD was that the PCB's be dechlorinated on site as part of the treatment. In order to perform a chemical dechlorination cost effectively, CWM elected to treat the soil using X*TRAX, and to dechlorinate only the condensed, recovered oil. The ROD had originally been developed assuming that the dechlorination would be performed on bulk contaminated soil. By dechlorinating the condensed oil from X*TRAX, CWM has greatly simplified this step. Also, a much smaller reactor and less excess chemicals can be used. Furthermore, no chemicals are added to the soil, avoiding the need to establish a secondary treatment standard for residual reagents in the soil returned to the site.

4. TEST RESULTS

CWM has performed extensive testing as part of the X•TRAX development program. Both simulated waste materials and actual regulated materials have been tested in the lab and pilot systems. The results of most of these tests have been previously reported[1,3]. The key results to date are summarized here. All values for feed and product concentrations are on a dry basis, as is the EPA's convention. Although the testing program has focused on PCB's to date, this should not be interpreted as a restriction on the X•TRAX process from other organic materials. To the contrary, CWM has pursued PCB testing as a means to validate the process on one of the most difficult organics to thermally desorb (because of its very high boiling point). Processing conditions that are successful with PCB's will almost certainly work for other volatile and semi-volatile organics. Also, a large percentage of Superfund sites that have organics as the primary contaminants, have PCB's as one of the POHCs.

4.1 Lab Testing Program

The principal use of the laboratory system has been in performing treatability studies for waste streams or remediation sites that are candidates for the X•TRAX process. Treatability studies are performed on a 50-100 lb sample, and yield results much quicker and at less expense than pilot testing. In all, 23 different test runs have been performed to date, 19 on actual RCRA or TSCA regulated materials.

As a benchmark of the system's capability, a simulated Superfund soil mixture prepared for the EPA was tested. Table 1 presents the results. This material was originally referred to by EPA as the Synthetic Analytical Reference Matrix, or SARM. It is now called Synthetic Soil Matrix, or SSM. SSM-1 had high organics concentration and low metals concentration. For both the volatile and semi-volatile organics, better than 99% removal was achieved.

Table 1

LABORATORY X•TRAX™
SSM-I

Compound	Feed Conc (ppm)	Product Conc (ppm)	Removal (%)
VOLATILES:			
Acetone	3,200	16.0	99.5
Total Xylene	2,900	9.50	99.7
Ethylbenzene	1,900	5.20	99.7
Styrene	240	< 0.005	> 99.99
Tetrachloroethylene	180	0.094	99.95
Chlorobenzene	130	0.180	99.86
1,2-Dichloroethane	46	0.062	99.87
SEMI-VOLATILES:			
Anthracene	3,100	12.0	99.6
Bis(2-Ethylhexyl)Phthalate	3,020	< 0.33	> 99.99
Pentachlorophenol	397	2.8	99.3

To date, eleven lab tests have been performed using TSCA regulated, PCB contaminated soils. Many of these tests were developmental, testing different gas system configurations. The results of this work have been summarized in Table 2.

Table 2

LABORATORY X•TRAX™
PCB Contaminated Soils

Run #	Matrix	Feed (ppm)	Product (ppm)	Removal (%)
RS0829	Sandy	5,100	9.7	99.3
GR0524	Silty Clay	962	21	97.8
GB0504	Topsoil	172	2.8	98.4

All of these materials had other minor organic contaminants, all of which were generally reduced to less than detection limits in the treated product (typically in the ppb range).

The most recent test was a series of four tests on soil, pond sludge and mixtures thereof. These materials were all from the same site, which is a large remediation project estimated to have in excess of 500,000 cubic yards of contaminated material. The organic contamination was a complex mixture of chlorinated semi-volatile organics, aromatics and organic solvents. A summary of the test results is presented in Table 3. Treatment standards for this remediation have not yet been developed. If required treatment levels are set on a risk basis, it is very probable that the X•TRAX treated product would be acceptable.

Presently eight treatability study samples are scheduled for testing in the lab system for this summer. The agenda is quite full, and continued activity in the area of thermal separation indicates that lab testing will continue to be in high demand.

4.2 Pilot Testing Program

CWM has performed 57 pilot test runs over the last 2-1/2 years using a variety of simulated, mixed and TSCA wastes. This has resulted in the generation of a wealth of treatability data as well as confirmed the operational reliability of the basic process equipment in the X•TRAX system.

Early in the development of the process, a large number of simulated waste streams were tested using a variety of organic chemicals to spike the feed. These results are summarized in Table 4 as an indication of system performance on various organic chemicals.

Table 3

LABORATORY X•TRAX™
Non-PCB Soil, Sludges and Mixture
(Conc = mg/kg)

Run No.	Parameter	Concentration		Removal (%)
		Feed	Product	
DB0627 Clay Soil	Total Solids (%)	94.1	100	N/A
	Azobenzene	3,190	4.9	99.8
	3,3'-Dichlorobenzidine	1,820	<0.66	>99.96
	Benzidine	842	ND	--
	2-Chloroanaline	828	ND	--
	Nitrobenzene	45.6	<0.33	>98.6
DB0629 Soil/Sludge	Total Solids (%)	73.1	100	N/A
	3,3'-Dichlorobenzidine	958	<0.66	>99.0
	Azobenzene	61.0	ND	--
	Benzidine	17.8	ND	--
DB0706 Sludge	Total Solids (%)	52.4	100	N/A
	Azobenzene	47,900	327	99.3
	Toluene	4,470	<0.42	>99.99
	3,3'-Dichlorobenzidine	3,590	18.4	99.5
	2-Chloroaniline	2,100	47.5	97.7
	Benzene	1,870	<0.21	>99.99
	Benzidine	1,010	3.7	99.6
	Aniline	267	43.3	83.8
DB0710 Sludge	Total Solids (%)	47.0	100	N/A
	3,3'-Dichlorobenzidine	1,070	<0.66	>99.94
	Azobenzene	35.7	ND	--

Table 4

PILOT X•TRAX™
Surrogate Feed Materials

Compound	Feed Conc (ppb)	Product Conc (ppb)	Removal (%)
Methyl Ethyl Ketone	100,900	< 100.0	> 99.90
Tetrachloroethylene	91,000	15.6	99.98
Chlorobenzene	61,810	6.5	99.98
Xylene	56,365	2.8	99.99
1,4-Dichlorobenzene	78,400	1.4	99.99
1,2-Dichlorobenzene	537,000	74.1	99.99
Hexachlorobenzene	79,200	300.0	99.62

The pilot system has recently completed a series of tests on ten PCB contaminated soils under a TSCA R&D permit at CWM's Kettleman Hills Facility. The last test was completed on January 26, 1990. Approximately 20 tons of material was tested.

The results of this testing are summarized in Table 5. Nine of the ten materials tested were reduced to below 25 ppm PCB in the treated product and four were reduced to below 10 ppm. This confirms at a relatively large scale that X*TRAX can separate PCBs from soil and produce a treated product with a very low residual PCB concentration. As with the lab testing, other organic chemicals were present at lower levels. These were generally reduced to detection limits (typically the ppb range). Oil and grease (and TPH) were reduced to near or below the 30 ppm detection limit, even when the feed had 45,000 ppm O&G.

Table 5

PCB CONTAMINATED SOILS
PILOT X*TRAX™

Run #	Matrix	Feed (ppm)	Product (ppm)	Removal (%)
0919	Clay	5,000	24	99.5
0810	Silty Clay	2,800	19	99.3
1003	Clay	1,600	4.8	99.7
0727	Sandy	1,480	8.7	99.1
0929	Clay	630	17	97.3

During the TSCA testing, the process vent was continuously monitored for total hydrocarbon emissions. Samples were also taken and analyzed for PCBs. Table 6 summarizes these data. The average release rate for hydrocarbons was very low and the PCBs were non-detectable.

Table 6

PILOT X*TRAX™
TSCA Testing - Vent Emissions

Run No.	Total Hydrocarbons (ppm-V)		Removal (%)	VOC (lb/day)	PCB* (mg/m³)
	Before Carbon	After Carbon			
0914	1,320	57	95.6	0.02	<0.00056
0919	1,031	72	93.0	0.03	<0.00055
0921	530	35	93.3	0.01	<0.00051
0926	2,950	170	94.2	0.07	<0.00058
0929	2,100	180	91.4	0.08	<0.00052

*Note: OSHA permits 0.50 mg/m³ PCB (1254) for 8-hr exposure

It should be pointed out that the solids feed system has presented the most problems during operation of the pilot X*TRAX. Soils with high sand concentrations presented few problems. Soils with high clay content proved very difficult to convey at a constant rate, and sometimes at any rate. Over the last two years four different feed systems have been tried. Each of the first three were modified several times before progressing to the next design. The current feed system has proven itself capable of metering and conveying anything from dry sand to damp clay that had to be picked out of an inverted drum. This design has been incorporated into the Model 200.

5. DISCUSSION OF RESULTS

In general, results to date have been quite good for the X*TRAX process. The basic process equipment has been reliable, and performance has exceeded expectations, especially with regard to the system's capacity. The area that deserves special attention is that of comparing the residual organic levels in the product with various applicable treatment standards.

Most of the test data to date on regulated material has been on PCB contaminated soils. Discussions with EPA have centered around meeting a treatment standard of 2 ppm. This is the analytical method's quantitation limit for PCB's when un-modified procedures are used. As can be seen from the data, X*TRAX has not achieved this standard. However, there is little or no basis for this numerical standard present in the regulatory citations. Rather, it has been implemented as a specific permit condition on a case by case basis. The PCB disposal regulations (40 CFR 761.60) simply state that non-liquid PCB's with concentrations over 50 ppm and less than 500 ppm have to be disposed in an approved landfill and that solids over 500 ppm have to be incinerated. The TSCA spill regulations (40 CFR 761.125) give cleanup requirements for soil as either 25 or 10 ppm, depending on the level of restricted access to the site.

Recently, the EPA has issued Superfund LDR #6A[4] as guidance to allowable treatment standards for Superfund soil and debris with respect to the RCRA land disposal restrictions. This document gives recommended numerical treatment standards to apply to Superfund soil and debris when the land disposal restrictions cannot be met. For PCBs the treatment standard is given as 0.1 - 10 ppm for soils containing less than 100 ppm, and 90 - 99.9% removal for soils greater than 100 ppm. Similar standards are given for other classes of organic compounds.

Table 7 is the same treatability data presented in Table 5, with the percent removal column replaced with the maximum residual level allowable under LDR guide #6A. Clearly the X*TRAX process meets the residual levels that could be allowed under these treatability guidelines. It would seem appropriate to strike a compromise position, somewhere between the LDR Guide's allowable values and the 2 ppm *defacto* standard.

Table 7
PCB CONTAMINATED SOILS
PILOT X*TRAX™
Comparison With LDR Guide #6A

Run #	Matrix	Feed (ppm)	Product (ppm)	Required Level* (max)
0919	Clay	5,000	24	500
0810	Silty Clay	2,800	19	280
1003	Clay	1,600	4.8	160
0727	Sandy	1,480	8.7	148
0929	Clay	630	17	63

*Based on 90% removal

An interesting observation about the residual PCB levels from the X*TRAX process is that the product concentration is relatively insensitive to the feed concentration. The product values are generally in the 5 - 25 ppm range, even when the feed is 5,000 ppm or higher. The residual levels are however, strongly dependent on the solids temperature and to a lesser extent the soil matrix. This is a source of comfort when working on a site where there are "hot spots." If the required treatment level is being achieved with the average feed material, the treatment of a hot spot should not exceed the standard.

Two of the materials tested in the pilot system were also tested in the lab system. Table 8 is a comparison of the results of these tests. Clearly, the residual levels in the product show good agreement, indicating that the lab system closely simulates the pilot system.

Table 8

COMPARISON OF LAB AND PILOT X*TRAX™
PCB Contaminated Soils

Matrix	System	Run ID	Amount (lb)	Feed (ppm)	Product (ppm)
Sandy	Lab	RS0829	19	5,100	9.7
	Pilot	RS0727	4,958	1,480	8.7
Silty Clay	Lab	GR0524	31	962	21
	Pilot	GR0810	4,584	2,800	19

6. COSTS

As is typically the case with waste treatment processes, the operating economics of X*TRAX are highly dependent on the waste type, specific contaminants and other project specific factors such as disposal requirements and restrictions, and the amount of material to be processed. All of this said, the treatment price for a material that meets the broad scope of acceptable feed for X*TRAX will usually fall in the $150 - $250 per ton of feed. This treatment price is in the appropriate range to make X*TRAX very competitive with both traditional disposal methods and also alternative treatment processes.

As with any on-site method, the mobilization charges to bring equipment on site need to be spread over the volume of material requiring treatment. To keep these mobilization charges within reason, a lower limit of about 5,000 cubic yards is appropriate for the X*TRAX Model 200.

7. SUMMARY AND CONCLUSIONS

CWM has progressed to a point in the development of the X*TRAX thermal separation process at which the following statements can be made:

- the X*TRAX thermal separation process has been demonstrated as effective on actual waste materials at both the lab and pilot scale

- pilot data has shown the process to have very low atmospheric emissions, both for PCBs and total organics

- very low residual contamination levels have been achieved for the treated product, typically in the 5 - 25 ppm range for PCBs and at the ppb level for most other organics, however, a 2 ppm treatment standard for PCBs cannot presently be met

- the process is tolerant of wide variation of organic levels in the feed

- the commercial system is easily modified to add stabilization for metal containing wastes

- the process is economically viable, with treatment price in the $150 - $250 per ton; it is suitable for remediations >5,000 yd^3

References

1. Swanstrom, C., Palmer, C., *X*TRAX™ Transportable Thermal Separator for Solids Contaminated with Organics*, **Air & Waste Management Association International Symposium on Hazardous Waste Treatment: Treatment of Contaminated Soils**, Cincinnati, Ohio, February 5-8, 1990.

2. Daley, P.S., *Cleaning up Sites with On-Site Process Plants*, **Environmental Science & Technology**, August, 1989.

3. Palmer, C.R., Hollenbeck, P.E., *Sludge Detoxification Demonstration*, **Incineration Conference**, May 1-5, 1989.

4. USEPA - Office of Solid Waste and Emergency Response, *Superfund LDR Guide #6A: Obtaining a Soil and Debris Treatability Variance for Remedial Actions*, Directive 9347.3-06FS, July 1989.